

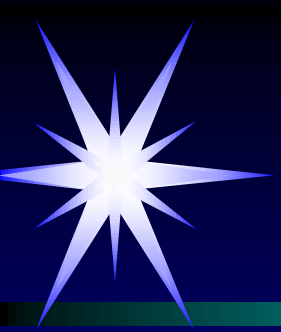


The Future of X-Ray Optics

Martin C. Weisskopf

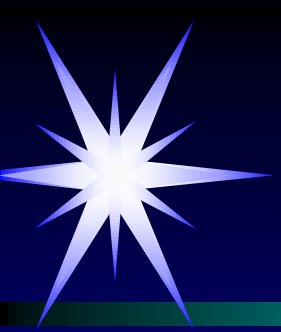
Presentation to the Town Hall Meeting

May 7, 2013



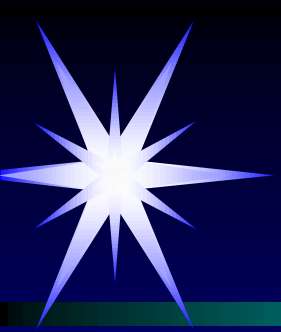
Looking to the Future.

- Progress in X-ray optics, with emphasis on the angular resolution, is central to the paradigm-shifting discoveries and the contributions of X-ray astronomy to multiwavelength astrophysics over the past 51 years.
 - Rocket, Uhuru, Einstein, Rosat, Chandra



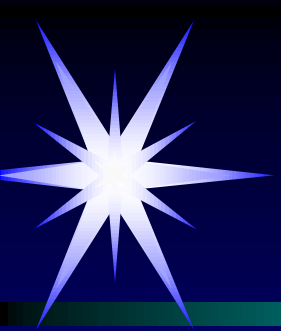
Learn from the Chandra experience.

- Clear scientific goals drove the design of the mission.
- Approaching our next X-ray mission in this way is more important than ever.
 - Why? The lesson of history is that this next mission will certainly not launch until after 2020 or, more likely, after 2030.



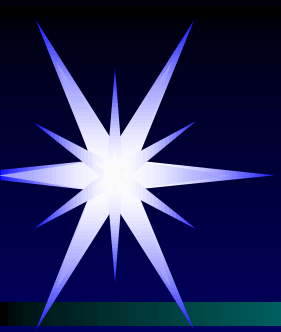
Take advantage of the hiatus.

- Use the time for developing technologies and manufacturing approaches that will satisfy our scientific needs for the next 51 years.
 - Seek fresh ideas from a broad community for the challenge that I will describe.



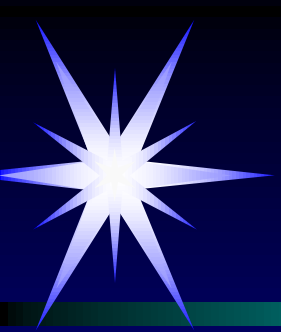
What should the next (notional) major X-ray mission be?

- Conservative (i.e., reasonable) requirements:
 - Sub-arcsecond on-axis angular resolution
 - Capability for wide-field deep surveys
 - Effective area sufficient to detect the first galaxies in an integration time $\approx$ Msec
 - Wide energy band to enable spectroscopy.
- To (inexpensively) realize such specifications will require a technology program of the type I shall describe.

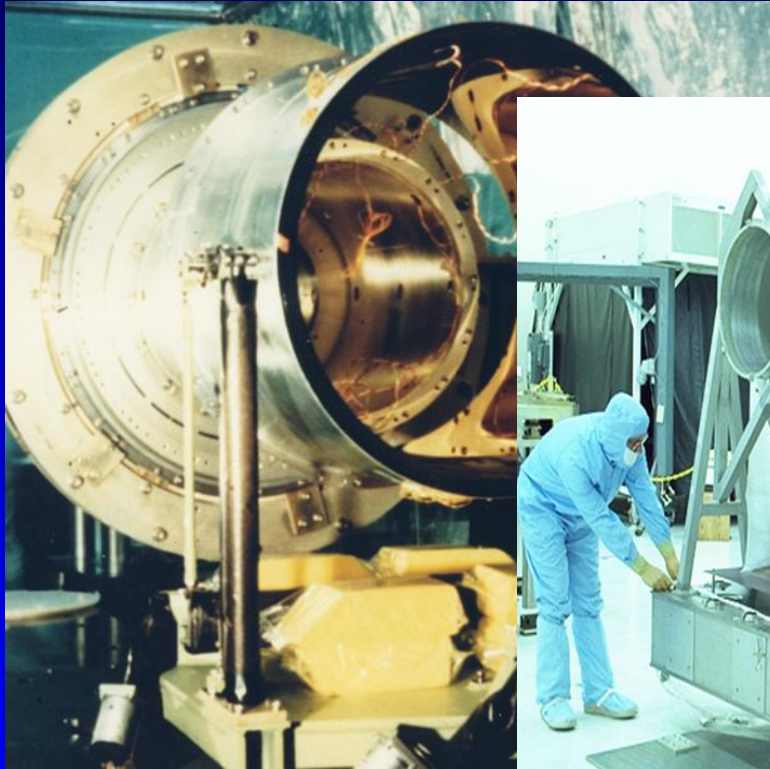


Learn from Chandra - develop the optics before we have a mission!

- Follow multiple, competitive, physics-based (not programmatic-based) approaches.
 - Currently several ideas but no proven answers.
 - Adjustable X-ray optics
 - Differential deposition
 - New materials
 - Even then, prove both technical readiness and manufacturing readiness.
- Defining and costing the mission before the technology is in hand hurts us.
 - Outrageous and self-fulfilling cost estimates.



Learn from Chandra - develop the optics first!



Demonstrate
technology



Demonstrate
manufacturing

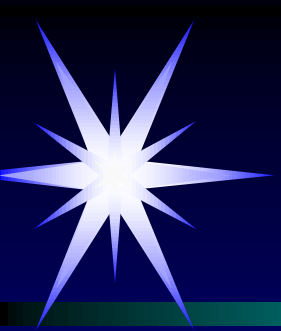


Build flight optics



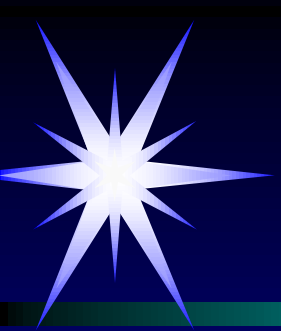
Do not drive the optics design to:

- satisfy an arbitrary mass limit.
 - Scientific performance takes precedence.
- address thermal and vibration issues.
 - Assume that external hardware will provide adequate thermal stability and vibration isolation.
- accommodate horizontal 1-g operations.
 - Assume & impose vertical alignment, assembly, metrology, and X-ray testing of the mirror assembly.



What will these optics look like?

- Grazing incidence technology.
- Full-shell or segmented --- unclear.
- Total weight --- unclear.
- Number of telescopes to achieve the required area --- unclear.



Conclusions.

- The most important next step is the development of X-ray optics comparable to (or better than) Chandra in angular resolution that far exceed Chandra's effective area.
- Use the long delay to establish an adequately funded, competitive technology program along the lines I have recommended.
- Don't be diverted from this objective, except for Explorer-class missions.